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TITLE: QUERY SYSTEM USING NON-UNIFORM BIN QUANTIZATION OF A HISTOGRAM

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MULTIMEDIA QUERY SYSTEM USING NON-UNIFORM BIN QUANTIZATION OF A HISTOGRAM

BACKGROUND OF THE INVENTION

1. Field of the Invention

[1] The present invention generally relates to a multimedia query using a histogram.

2. Background of the Related Art

[2] Images or pictures can be stored on a computer in digital form. Utilizing digital images is becoming increasingly popular. This popularity may be attributed to the low cost of producing digital images as compared to images taken with a conventional camera using film. One advantage is digital images can be distributed electronically via the Internet. Another attribute is that there is no incremental cost per image to produce the digital image by digital camera. Accordingly, a user of a digital camera may tend to take many pictures. Further, there is an enormous amount of digital images available to users via the Internet. It is often a great task for a user to locate a digital image through a search. Accordingly, search engines exist for searching for digital images. However, these search engines suffer from at least two disadvantages. One disadvantage is that not all images are represented in the same way for purposes of the search. For example, two images may be represented by a histogram for searching purposes, however the histograms utilize different protocols which are not compatible. Another disadvantage is that data relating to an image (i.e., a histogram) may be only partially transferred between computers on a network and cause that partial transfer of the histogram to be useless.

SUMMARY OF THE INVENTION

[3] Objects of the present invention at least include overcoming the above-discussed disadvantages. Particularly, embodiments of the present invention allows for increased compatibility between two histograms and allows for a portion of a histogram to be utilized in a query.

[4] Embodiments of the present invention relate to a method for receiving a first sequence of values and a second sequence of values. Each value in the first sequence and each value in the second sequence is associated with a category and a magnitude. In embodiments of the present invention, the magnitudes are thresholds. In embodiments of the present invention the categories are bins. In embodiments of the present invention each value of a sequence is a bit. In the order of the values of both the first sequence of values and the second sequence of values, no adjacent values have the same category. Accordingly, in embodiments of the present invention, when a histogram is transferred or received for analysis, the order of the information in the histogram can be strategically ordered to increase compatibility of histograms and utilize partials of histograms in an image search.

[5] In particular, when a histogram is transferred, bits are ordered or given a priority of the placement of the bits over the category that the bit is in. For example, when a histogram is transferred, the first bit of every category is transferred for the second bit of every category. In embodiments of the present invention, since each bit in the order of bits in each category is associated with a different magnitude, compatibility can be accomplished. Further, since bits

are transferred according to magnitude and not according to a category, the initial bits of a transferred histogram can be utilized without needing the remainder of the bits.

[6] Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objects and advantages of the invention may be realized and attained as particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[7] Fig. 1 is a view explaining an example of bin quantization which is interoperable.

[8] Fig. 2 is an exemplary view explaining a phase in which multimedia data represented as a histogram are transferred in the order of bit priority.

[9] Fig. 3 is an exemplary view explaining a partial query using a histogram of which transfer is interrupted.

[10] Fig. 4 is an exemplary view explaining the relationship between a threshold and histogram data.

[11] Fig. 5 is an exemplary view illustrating a HMMD color space.

[12] Fig. 6 is an exemplary view explaining a 184 level quantization method viewed in a HMMD cross-section.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[13] The following detailed description of embodiments of the present invention depicts only histograms for the purpose of exemplary illustrating the method of a multimedia query using the histogram. The present invention can be equally effective when applied to other types of histograms.

[14] Search engines may use global and local color information and texture information for image retrieval. Among them, the color information is an important element in effective image query. Embodiments of the present invention relate to a color histogram. A histogram is a chart representing color distribution in multimedia data (i.e., images). A category or bin number of a histogram is determined according to how a given color space is quantized. Although each bin value may be represented by a decimal, it also can be represented by a quantity of N bits smaller than a fractional representation space. For example, it is generally known that spaces can be saved substantially without degradation of performance by representing 8 bits, i.e., decimals between 0 and 1, by 256 kinds of values. In a uniform quantization method, values between 0 and 1 are divided by a uniform width, quantized and represented, while, in a non-uniform quantization method, they are divided by a non-uniform width, quantized and represented.

[15] In non-uniform quantization, it is possible to achieve improved performance. For instance, a section of an important bin value can be divided more finely than a section having a bin value having no divisability. For example, in case of a histogram, most bin values consists

of a number smaller than 0.2, and thus it is meaningless to divide a number more finely than 0.2. In this example, bin quantization using non-uniform quantization can be effectively employed.

[16] Embodiments of the present invention overcomes problems of interoperability among histograms. It may be difficult to compare bin values that are quantized by a different number. For example, if a certain histogram quantizes and represents a bin value by $2^4=16$ in order to represent each bin value by 4 bits, while another histogram quantizes a bin value by $2^2=4$ in order to represent each bin value by 2 bits. Then, the comparison of these values is impossible, because there is no information about the method for quantization of each bin value. Therefore, to ensure interoperability a quantization method, used by the two histograms, must conform to a particular protocol.

[17] Embodiments of the present invention overcomes problems in progressive bit processing of histograms. For example, when a histogram is transferred through a network, it can be transferred in the order of bins according to the coding scheme of the histogram or in the order of bits of the bin. When a histogram is transferred in the order of bins, every bit of the first bin are transferred and then every bit of the next bin is transferred. When a histogram is transferred in the order of bits, the first bit of the first bin is transferred and then the first bit of the second bin is transferred. For instance, after every first bit representing each bin value are transferred, every second bit representing each bin value are transferred. In such a coding scheme, if the transfer is interrupted before the histogram is completely transferred, the comparison of the histogram has to be enabled only by the transferred part of the histogram.

[18] With respect to histogram information of multimedia data, a color space can be quantized differently for different purposes. Likewise, a bin value can be quantized differently for different methods for representing each bin value. For example, in a particular application, 4 bits are adequate for representing a bin value, while, in another application, at least 8 bits are adequate for the corresponding use. In order to calculate similarity between those applications, it is necessary to ensure the result of the comparison between them using at least the same 4 bits. However, in the non-uniform quantization, there are various quantization methods, so it is possible to compare them when the different quantization methods are employed. Accordingly, embodiments of the present invention relate to a method for quantizing a bin value to enable interoperability between histograms.

[19] Fig. 1 is a view explaining an example of bin quantization, which is interoperable. In 101 of Fig. 1, a bin value is represented as 0 or 1 based on a particular threshold TH1 for 1 bit representation. A histogram represented by such a method and 2 bit representation capable of direct comparison are described in 102 of Fig. 1. That is, a bin value is represented in four ways by using the threshold TH1 described in 101 of Fig. 1 and two additional thresholds (TH2 and TH3). Comparison between histograms 101 and 102 are possible, since the threshold TH1 is used in both histograms.

[20] Fig. 2 is a view explaining exemplary embodiments of the present invention. As shown in the drawing, a coding scheme can be considered in which a first bit of every bin (bin 1 ~ bin N) is transferred and then a second bit of every bit is transferred. In other words, in instead of all the bits of a bin being transferred together, all the bits having the same association

in the bins are transferred together. In the event that transfer is interrupted before the completion of the transfer as shown in Fig. 3, query can be executed only by transferred parts.

[21] In order to assure a certain degree of performance, when each bin is quantized by n bits and represented, it is necessary to represent optimum information which can be represented by each bit in the order of bits. For this purpose, the case of quantizing a bin value will be considered as follows. Firstly, assuming that a bin value is represented by 1 bit, one optimized threshold will be used to show the highest performance when the bin value is represented by two values, i.e., 0 or 1. In addition, in case of representing the bin value by 2 bits, three optimized thresholds will be used to show the highest performance when the bin value is represented by four values. At this time, if only one bit of two bits can be used, the best performance can be expected when the optimized performance achieved at the above-described 1 bit representation is obtained. Therefore, in case of representing the bin value by 2 bits, one of the three thresholds must be a threshold used in representing the bin value by 1 bit. In other words, the first bit of every bin must be associated with the same first threshold value. Accordingly, the second bit of a bin is also associated with the same second threshold value. This relationship of position in a bin and associated threshold continues throughout subsequent bits in each of the bins in a histogram.

[22] In addition, the first bit indicates division of a value based on the above-described threshold of 1 bit as shown in Fig. 4. The second bit indicates division of the section of the value divided by the first bit. In this way, a n-th bit indicates division of each section divided by a (N-1)-th bit.

[23] In other words, as illustrated in Fig. 4, if a bin value is represented by 1 bit in 401, it is divided based on a threshold Th1. If the bin value is represented by 2 bits in 402, each of sections divided by the threshold Th1 is divided again by the previously used threshold Th1 and another thresholds Th2 and Th3. If the bin value is represented by three bits in 403, each of sections divided by the previously used thresholds Th1, Th2 and Th3 and another thresholds Th4, Th5, Th6 and Th7. In this manner, when the bin value is quantized and represented by a small number of bits so that progressive bit processing can be achieved, a certain degree of query performance can be assured by using only transferred parts even though transfer is interrupted during the transfer of a histogram. Moreover, bin values of the histogram can be queried by using only parts of total bits according to the use of the query. These embodiments of the present invention allow for adequate query performance, even though all bits of a histogram are not utilized.

[24] Fig. 5 describes a HMMD color space for explaining a progressive histogram using the HMMD color space in accordance with embodiments of the present invention. The HMMD color space is a color space of a double cone shape. The HMMD color space is described in U.S. Application Serial Nos. 09/239,773 filed April 29, 1999 and 09/865,459 filed May 29, 2001, which is assigned to the same entity, and the entire disclosure thereof is incorporated herein by reference. The central axis thereof is represented as SUM ([MAX(RGB) + MIN(RGB)]/2), which corresponds to brightness. Fineness is increased in the order of center to peripheral sides of the cone, which is represented as DIFF(MAX(RGB)-MIN(RGB)). The angle of the cone indicates a color, which is generally represented as Hue.

[25] Fig. 6 illustrates an example of 184 level quantization of the HMMD color space explained in Fig. 5. As shown in Figure 6, first, a region is divided into 5 partial regions on the basis of DIFF and then subdivided on the basis of HUE and SUM again, thereby representing 184 partial regions in all. These produce a histogram constituted by 184 bins, respectively, as follows. First, indexes of two bin values by using a threshold value 2.5/310.0 for representing 1 bit bin value are produced. Thereafter, indexes of four bin values by using three threshold values 2.5/310.0, 9.1/310.0, and 30.0/310.0 for representing 2 bits bin values are produced. Also, 16 indexes by deciding 0.0 of bin value as an index for representing 4 bits bin values, producing two indexes by bisecting a period of 0 and 0.6/310.0, producing an index in the period of 0.6/310.0 and 2.5/310.0, producing five indexes in the periods of 2.5/310.0 and 19.0/310.0, producing six indexes in the periods of 19.0/310.0 and 85.0/310.0, and designating the value above 85.0/310.0 as an index are produced. On the other hand, an index by deciding 0.0 of bin value as an index for representing 6 bits bin values, producing four indexes by diving a period of 0 and 0.6/310.0 into four equal parts, producing four indexes by diving the period of 0.6/310.0 and 2.5/310.0 into four equal parts, producing ten indexes by dividing the periods of 2.5/310.0 and 19.0/310.0 into ten equal parts, producing thirty indexes by dividing the periods of 19.0/310.0 and 85.0/310.0 into thirty equal parts, producing fourteen indexes by dividing the periods of 85.0/310.0 and 121.0/310.0 into fourteen equal parts, and designating the value above 121.0/310.0 as an index is produced.

[26] Embodiments of the present invention relate to a histogram. The histogram may include the following attributes. Threshold values used in representing the number of n of bits

for securing interoperability, capable of comparing the histograms represented by the number of bits which are differ from each other, including threshold values used in representing the number of N'(N'<N) of bits, when bin value is represented with the number of N of bits by quantization in order to query multimedia using histogram. The histogram is a histogram.

[27] Embodiments of the present invention relate to a multimedia query method. The method may include correcting the other bin value as smaller number of N of bits and then comparing two values if one of two histograms represents bin value with M, the other represents bin value with N(M>N), when performing the comparison between histograms represented with the number of bits which are differ from each other. The correcting process may be performed by summing the bin values divided by the threshold values (TH1s) existing between two threshold values used in representing the number of N of bits to the rest threshold values except for threshold values (TH2s) used in representing the number of N of bits, among threshold values (TH1s) used in representing the number of M of bits. The histogram may be a histogram.

[28] Embodiments of the present invention relate to a histogram quantization method. The method may comprise the following steps. Dividing HMMD color space by a histogram, the histogram comprising threshold values used in representing the number of n of bits for securing interoperability, capable of comparing the histograms represented by the number of bits which are differ from each other, including necessarily threshold values used in representing the number of N'(N'<N) of bits, when bin value is represented with the number of N of bits by quantization in order to query multimedia using histogram, at this time. Producing indexes of two bin values by using a threshold value 2.5/310.0 for representing 1 bit bin value. Producing

indexes of four bin values by using three threshold values 2.5/310.0, 9.1/310.0, and 30.0/310.0 for representing 2 bits bin values. Producing 16 indexes by deciding 0.0 of bin value as an index for representing 4 bits bin values, producing two indexes by bisecting a period of 0 and 0.6/310.0, producing an index in the period of 0.6/310.0 and 2.5/310.0, producing five indexes in the periods of 2.5/310.0 and 19.0/310.0, producing six indexes in the periods of 19.0/310.0 and 85.0/310.0, and designating the value above 85.0/310.0 as an index. Producing an index by deciding 0.0 of bin value as an index for representing 6 bits bin values, producing four indexes by diving a period of 0 and 0.6/310.0 into four equal parts, producing four indexes by diving the period of 0.6/310.0 and 2.5/310.0 into four equal parts, producing ten indexes by dividing the periods of 2.5/310.0 and 19.0/310.0 into ten equal parts, producing thirty indexes by dividing the periods of 19.0/310.0 and 85.0/310.0 into thirty equal parts, producing fourteen indexes by dividing the periods of 85.0/310.0 and 121.0/310.0 into fourteen equal parts, and designating the value above 121.0/310.0 as an index.

[29] Embodiments of the present invention relate to a histogram. The histogram includes n-th bit represented by quantization of bin value, wherein the nth bit bisects the respective regions divided into (N-1)th bit in order to perform a progressive bit processing capable of retrieving by using only a bit, which is smaller than N, when bin value is represented with the number of N of bits by quantization in order to query multimedia using histogram. The histogram may be a histogram.

[30] Embodiments of the present invention relate to a histogram encoding method. The method may include arranging the first bit of every bin first and then arranging the second

bit, when encoding the histogram representing bin value to perform the progressive bit processing. The histogram may be a histogram.

[31] In the present invention, in a multimedia query using a histogram, free comparative query between every servers on the internet, not one server, is enabled by providing interoperability by which comparative query between histograms bin quantized by different number of bits, when considering spatial efficiency by representing a bin value by bits of a decimal. In addition, when the bin value is quantized and represented by a limited number of bits, a certain degree of query performance can be expected by executing query using only parts of the bits, for thereby enabling query at the time of transfer interrupt caused by a problem on a network and performing a query service conforming to the use of the query or the environment of a client.

[32] The foregoing embodiments and advantages are merely exemplary and are not to be construed as limiting the present invention. The present teaching can be readily applied to other types of apparatuses. The description of the present invention is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art.